Mosquito Control in Vermont: Providing Information for Citizens and Controllers

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Introduction

The goals of this project consisted of compiling information about mosquito control issues relevant to Vermont and providing it to the Salisbury Conservation Commission, the Lemon Fair Insect Control District, and local residents. We completed this project to fulfill the service-learning component of our Environmental Studies Senior Seminar (ES401), which required that we address a local environmental concern through collaboration with the community. Our work focused on the use of pesticides and their alternatives in management of mosquito populations at the district, household, and individual level. We incorporated our final products into a website to make it accessible not only to our community partners, but to the general public as well. These products are aimed at reducing the need for pesticides by suggesting means of using them in a targeted and efficient way. For example, we recommend continual GPS-monitoring and surveillance of areas particularly prone to flooding in order to pinpoint mosquito breeding grounds and more precisely direct the application of pesticides. We make this and other recommendations for future projects in the hope that our work will continue past the end of this semester.

Pest control, and in particular mosquito management, is an environmental issue of international concern because of the health concerns associated with it. Mosquitoes can serve as disease vectors for potentially serious illnesses, including malaria, West Nile Virus (WNV), and Eastern Equine Encephalitis (EEE) (Kerr and Jarris 2001). Each year hundreds of millions of people worldwide develop malaria, an estimated 1-3 million of whom die (McGinn 2002). Pesticide-spraying programs designed to reduce mosquito populations are often implemented as a means of limiting disease transmission. While malaria poses almost no threat in Vermont, WNV and EEE have been discovered in the bodies of small numbers of mammals and insects.

No known human cases of EEE have been documented in Vermont, and the only known case of WNV occurred in 2002 (Kerr and Jarris 2001). Though mosquito-transmitted diseases pose a very low-risk for Vermont residents, public and private mosquito control measures can nevertheless serve a preventative function and safeguard against potential outbreaks.

The most compelling reason for the continuation and the implementation of mosquito spraying programs in Vermont concerns maintaining quality of life. Both anecdotal evidence and field surveys suggest that mosquito populations have been steadily increasing over the past 20 years, and continue to grow. In July 1989, the Vermont Emergency Board granted $100,000 to the Brandon-Leicester-Salisbury-Goshen (BLSG) Mosquito Control Group in response to the reputedly "horrendous" mosquito problem in these towns (Vermont Department of Agriculture). The endowment of this grant also came in part as a reaction to negative media coverage, which hurt the tourist industry in these areas.

Currently, there exist two mosquito control districts in Vermont: the BLSG Mosquito Control Group and the recently formed Lemon Fair Insect Control District, which includes the towns of Bridport and Cornwall (Figures 1-3). The Lemon Fair Insect Control District formed in April 2006 in response to the complaints of residents that mosquitoes detracted from their quality of life by preventing them from outdoor chores and keeping them from enjoying various recreational activities.

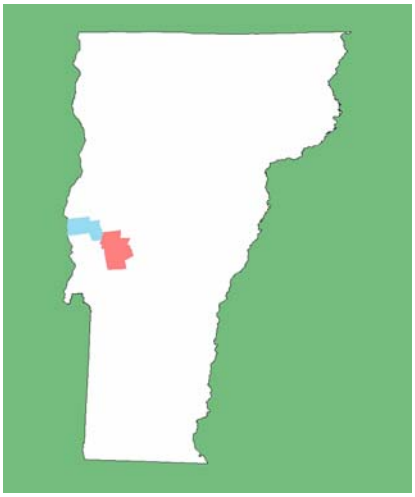


Figure 1. This map depicts the location of the two mosquito control districts in central Vermont. The pink represents the area covered by the BLSG mosquito control group, while the blue designates the extent of the Lemon Fair Insect Control district.

Figure 2. This map depicts the Brandon-Leicester-Salisbury-Goshen Mosquito Control Group in Vermont.

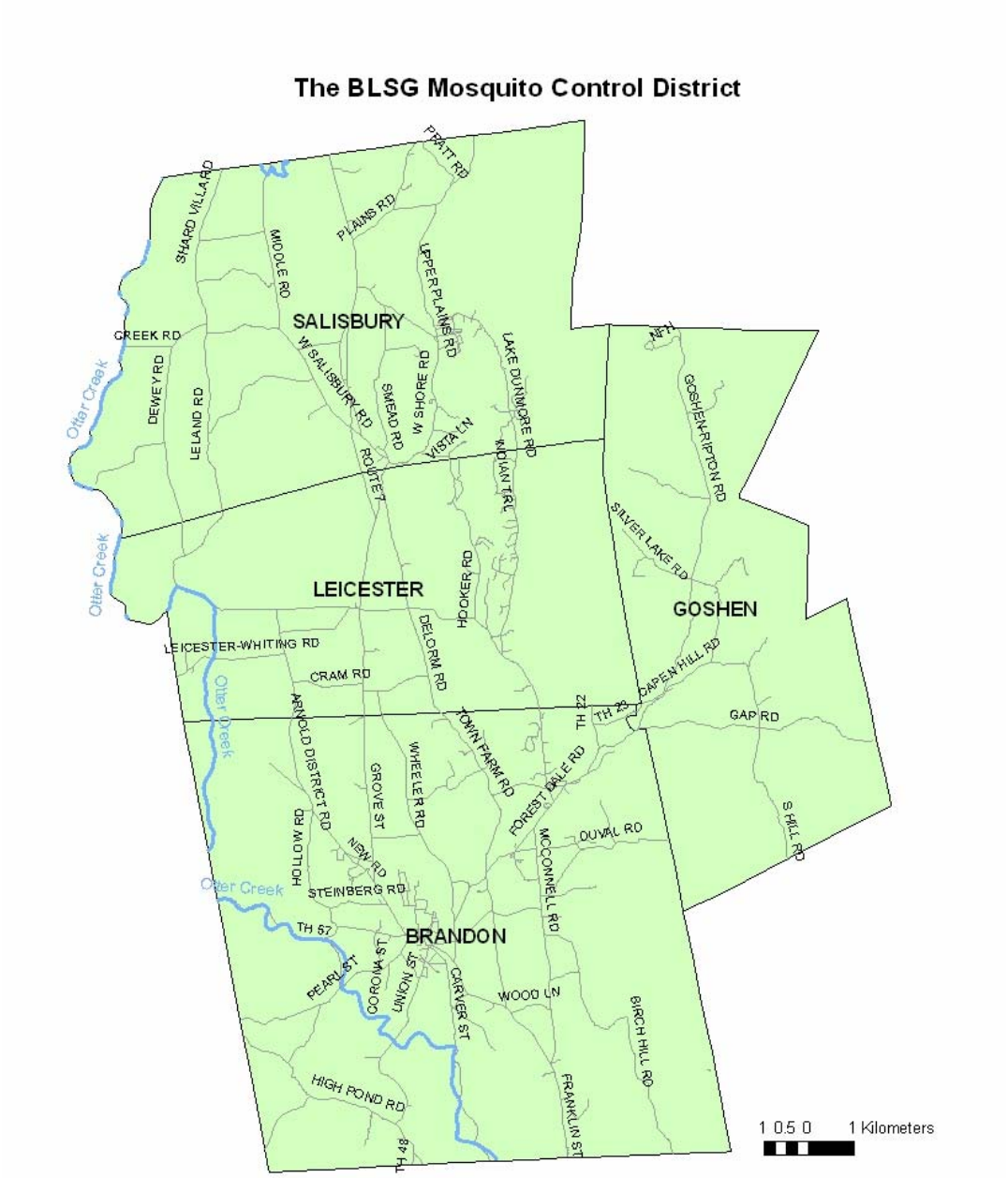
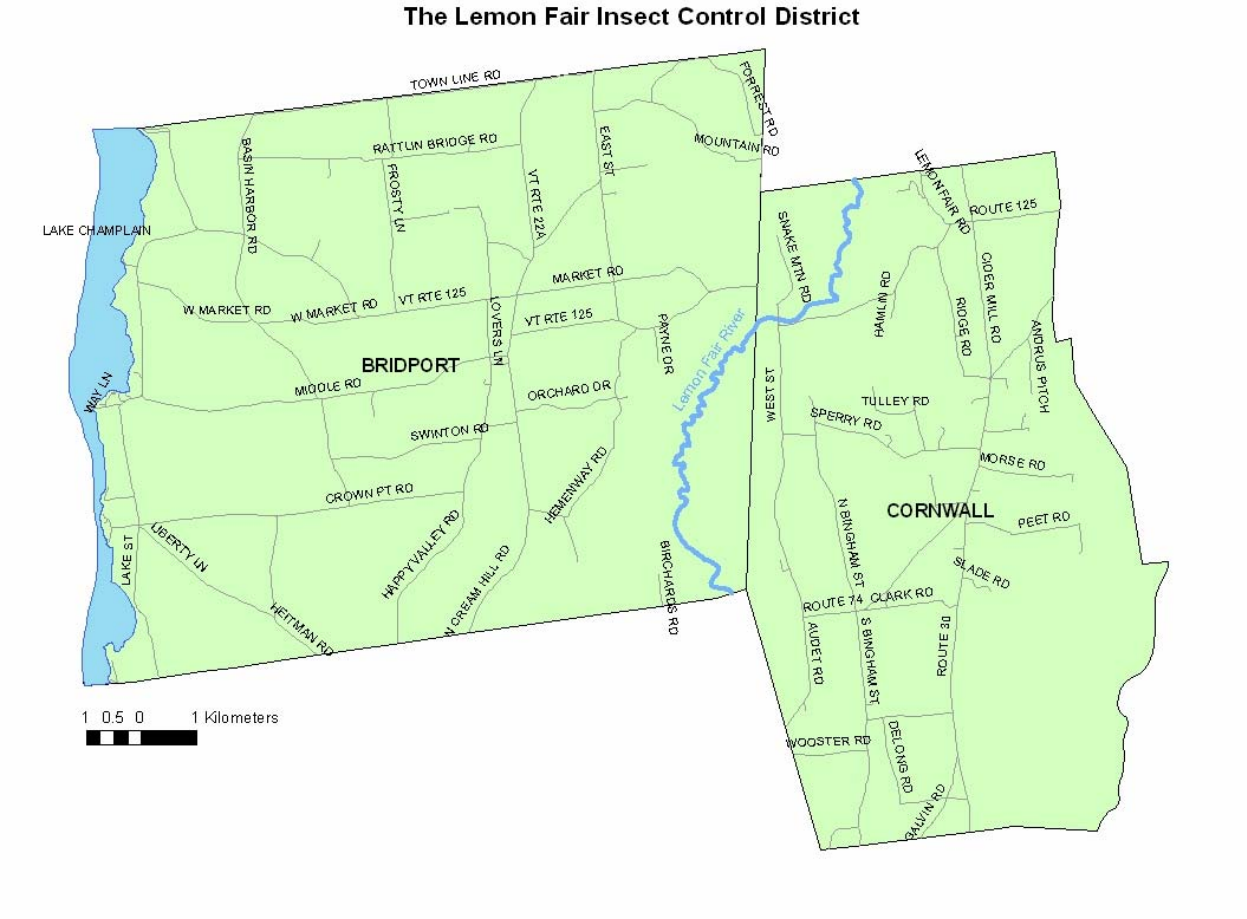


Figure 3. This map depicts the Lemon Fair Insect Control District, which includes the towns of Bridport and Cornwall, VT.



Both districts formed with the intention of controlling mosquito populations on both public and private lands. The districts receive funding directly from appropriations from participating towns, which are partially reimbursed by the state from money generated through boating registration fees. The BLSG district encompasses 72,131 acres of land and uses both larvicides and adulticides to manage mosquito populations; the Lemon Fair district, while still in its infancy, plans to use only biological larvicides, primarily *Bacillus thuringiensis israelensis* (Bti), to manage its 48,032 acres. Our community partners from the Salisbury Conservation Commission and the Lemon Fair District expressed an interest in working with us to gather

information about current mosquito control methods and alternatives, which could be provided to the districts and their residents.

In our research, we concentrated on comparing available organic and synthetic pesticides according to such measures as efficacy, associated health risks, labor intensiveness of application, and environmental persistence. We examined mosquito control methods at two different scales: those used by the districts for spraying large areas of public and private land, and those used at the household or individual level. We also analyzed methods for mosquito management that do not require either organic or synthetic pesticides.

To effectively communicate our research findings to the community, we designed four fact sheets, each available to the public through our website at: https://segue.middlebury.edu/sites/LemonFairMosq. We also expanded upon a survey that the Lemon Fair district intends to distribute to its residents each year; we hope that our modifications will result in a more comprehensive understanding of the perceived mosquito activity in this area.

Another facet of our project involved sampling for mosquito larvae and using GPS technology to document mosquito breeding grounds. We then mapped the areas we had identified as potential breeding grounds. Additionally, on March 16 and April 20, we took aerial photographs of water-saturated landscapes in Bridport and Cornwall by plane. Through comparison of the photos, we noticed how dramatically water levels throughout the Lemon Fair district had changed in a little over a month. In particular, we envision these portions of our project as serving as examples of important monitoring projects that could be adopted by the mosquito control districts in the future. We hope the final products presented here and in our website will provide useful information to the Lemon Fair Insect Control District, the Salisbury Conservation Commission, the BLSG district, and Vermont residents.

Methods

Project Goals

The first official meeting of our mosquito control project group took place a few weeks into the spring 2006 semester. During this meeting, we named our group the "Skeeter Beaters" and discussed our project goals. However, after a meeting with Tom Vanacore, one of our community partners from the Lemon Fair Insect Control District, we modified and refined some of the goals we had initially discussed. During this meeting, Mr. Vanacore answered our questions and helped us develop goals that would fulfill the needs of the Lemon Fair district.

We decided upon the following objectives: (i) create three fact sheets that would inform Vermont citizens about the issues surrounding mosquito control, (ii) collect GPS data of the mosquito breeding grounds in Bridport in order to create a map of these areas, (iii) update the Lemon Fair district survey concerning mosquito control such that it asks more specific questions, and (iv) develop a website open to both residents and people involved directly in mosquito control. In particular, we anticipated that the website would function as a database from which to obtain information regarding mosquito control and view parts (i) and (ii) of our project.

In an attempt to familiarize ourselves with the Lemon Fair Mosquito Control District, we flew over the area it encompasses. Ed Peet, a Cornwall resident and experienced pilot with a small airfield on Peet Road, took us up in his plane, three at a time, to view of the Lemon Fair River spring floodplains, which constitute prime mosquito breeding grounds. This experience gave us the opportunity to capture many of the images presented on our website. Moreover, it conveyed to us the magnitude of the mosquito problem in this region of Vermont.

Fact Sheets

We decided on three topics for the fact sheets. The first would inform residents of Vermont about how they can control mosquito populations on their own property. This fact sheet would deal with alternative products available on the market and any risks associated with them. The second would delineate the large scale mosquito control measures that the Vermont Agency of Agriculture employs. The third would address mosquito-transmitted disease in Vermont. We designed all three fact sheets with local residents in mind.

During the first few weeks of our project, we collectively researched the various topics we intended to discuss in our fact sheets. We used our "wiki" webpage, to which all the members of our group had access, as a place to combine all of our research. A "wiki" is a type of webpage that allows for many people to edit and update a site simultaneously. Thus, a wiki decreases the reliance upon mass emails, telephone calls, and exchange of hard copies. Carrie Macfarlane, the Middlebury College Reference and Instruction Librarian for the Sciences, created this incredibly helpful tool for our class.

With our preliminary research completed, we split into three groups, each of which worked on a separate fact sheet. After writing a draft of each fact sheet, we developed a uniform template for all of them. Since we planned on posting them on our website and making them accessible to Vermont citizens, we wanted to make them consistent and easy to read.

GPS Data Collection

In our discussions with Mr. Vanacore, we learned that very little information existed regarding the location of perennial mosquito breeding grounds throughout the Lemon Fair district. Since the district plans to use only larvicides, and no adulticides, to manage mosquito populations, he felt it important to create a map of breeding areas. The advanced knowledge of

GIS and GPS techniques that many members of our group possess allowed us to collect this data with Mr. Vanacore's help.

We began by developing a GPS file that would allow us to map the requisite types of information. We used GPS Pathfinder software to equip one of the GPS units with this file, and then began our field research. Our field expeditions to collect GPS data took us to a number of different areas within Bridport. We collected data from: a large area of farmland that borders the Lemon Fair River off of Hemenway Road, the flooded banks of the Lemon Fair River directly under the Lemon Fair Bridge, and a small breeding area off of Payne Road. In these areas, we outlined breeding grounds, which we recognized by the presence of larvae.

After collecting our GPS data, we uploaded it onto a computer at Middlebury College. We then, used the Geography department's GIS software to create a map of the areas we had identified as mosquito breeding grounds and compared it to maps of Class 2 wetlands and frequently flooded soils, which we obtained from the Addison County Regional Planning Commission office.

Website

After deciding to make a website, Professors Costanza-Robinson and Diane Munroe put us in contact with Mr. Shel Sax, the Director of Education Technology at Middlebury College. In our first meeting with Mr. Sax, we presented him with a list of the elements we envisioned posting on our website including: a brief synopsis of the history of mosquito control in Vermont, an outline of the development of our project, three fact sheets (as pdf files for public distribution), photographs captured from Mr. Peet's plane, a map of our GPS data, discussion pages, and contact information for all the members of our group and our community partners. Mr. Sax recommended that we use a program called Segue to construct our website rather than

Dreamweaver, because of the comparative simplicity of the former. The next week, Mr. Sax gave us a quick tutorial on how to use Segue.

After establishing the basic layout of our website, we added the various elements listed above, over the course of the semester. However, including discussion pages turned out to be a more difficult proposition than we had originally realized, because it required that we find someone to continually oversee added content. For this reason, we decided against including an interactive component on our website. In addition to the elements mentioned earlier, we added an informational page that describes and diagrams the life cycle of mosquitoes. We also adjoined a page listing supplemental resources about mosquito control.

Survey

After obtaining the surveys distributed at a Bridport town meeting in 2005, we imported the E911 addresses that residents had listed on their surveys into a GIS database. The survey asked people to rate the mosquito problem in 2004 and 2005 respectively. We coded the responses as follows: Extremely Bad = 4, Moderate = 3, Light = 2, Little or None = 1. Once we had these numbers in our GIS database, we mapped them on top of the Bridport town map in order to see the locations of reportedly extreme problems.

Mr. Vanacore assured us that the revised survey would be handed out at town meetings in both Bridport and Cornwall in subsequent years and that the information would be mapped to determine whether, according to residents, the mosquito control measures taken by the Lemon Fair Insect Control District had effectively reduced mosquito populations. We revised the survey in order to elicit more detailed information from respondents about the mosquito problems in the area. We wanted the surveys to ascertain what measures, if any, the citizens had taken to control mosquito populations and how much time they typically spent outside.

Important Correspondences

Throughout the semester, we had many important meetings and conversations with members of the Middlebury College community and residents of surrounding towns, which have helped us tremendously in directing our research and project goals. We have mentioned most of the people that contributed to our project, but there remain a few left to acknowledge:

Chris Fastie, a Visiting Research Scholar in Biology at Middlebury College and a member of the Salisbury Conservation Commission, attended our class on numerous occasions and gave us feedback on the progress of our project. In particular, he ensured that our final products would benefit the people of Salisbury.

Alan Graham, the Vector Specialist for the Vermont State Department of Entomology, and Jon Turmel, the Vermont State Entomologist, were themselves sources of valuable information. Mr. Turmel spoke with our class and provided us with information about the state of mosquito control in Vermont. He also informed us of the current mosquito control techniques practiced locally. Mr. Graham supplied us with a great deal of the Vermont-specific data that demonstrated how the mosquito problem has escalated over the past couple of years.

Results

We intend the products of our project to serve as useful sources of information for not only our community partners, but more generally for Vermont citizens. The following sections describe our final products, which we incorporated into our website. Additionally, our project involved the presentation of our GPS work to members of the Lemon Fair Insect Control District with the recommendation that this work continue.

Fact Sheets

The three fact sheets we developed each concern a different issue regarding the dangers inherent to mosquitoes and mosquito control. The first fact sheet, entitled *Mosquito Control Methods for in and around Your House and Place of Work* (Appendix 1.1), gives information about types of mosquito control not included in district-wide programs. The control methods listed on this fact sheet describe changes that individuals can make to their property and lifestyle that will reduce mosquito breeding grounds, limit larval hatches, and repel adult mosquitoes. This information could have broad implications if distributed to Vermonters both in and outside of the mosquito control districts. The individual control methods outlined in this fact sheet should constitute the first step in an organized mosquito control effort, yet we recognize the difficulty in galvanizing a large group of citizens. Ideally though, this fact sheet will inspire people to take personal measures to limit the number of mosquitoes in Vermont.

The second fact sheet, *How Does Vermont Control Mosquito Populations?* (Appendix 1.2), appertains directly to those citizens living within control districts or in towns that are considering forming or joining a control district. It introduces the large scale controls currently used by the BLSG and Lemon Fair districts. Concentrating on four widely used insect control agents, *Bacillus thuringiensis israelensis*, *Bacillus sphaericus*, Agnique monomolecular film, and pyrethroid sprays, the fact sheet explains the function of each product, the situations that warrant its use, and its associated dangers. The presented information should assist citizens to understand current mosquito control methods and make informed decisions regarding the inclusion of their property in district-wide pesticide application.

The third fact sheet, entitled *Mosquito-Transmitted Diseases in VT* (Appendix 1.3), describes the risk for Vermonters of contracting West Nile Virus (WNV) and Eastern Equine

Encephalitis (EEE) from mosquitoes. Educating people about the diseases associated with mosquitoes and realistically portraying the risks of infection may reduce public anxiety. Thus, this fact sheet emphasizes the scarcity of WNV and EEE in Vermont and the typically mild symptoms associated with the former, so that citizens neither underestimate nor exaggerate the risks of mosquito-related diseases in Vermont when discussing insect control programs. Finally, each fact sheet exists on our website in pdf format to make them easy to download and distribute.

Surveys

We used the responses to the original version of the Lemon Fair Mosquito Control District Survey to create a set of maps that illustrate the survey results. These maps geographically demonstrate the public's perception of Vermont's mosquito problem and how it has changed between 2004 and 2005 (Appendices 2.2 and 2.3). We included these maps on our website, because they show a significant increase in the perceived mosquito problem, which has led to the formation of the Lemon Fair Insect Control District. In the future, the surveys will reflect the effectiveness of the mosquito control programs to enhance the quality of life in Vermont. We also revised Lemon Fair's survey (Appendix 3.1) to elicit more specific information from respondents. The revised survey (Appendix 3.2) utilizes the same rating scale as the original version in order to maintain continuity in the ranking of the perceived mosquito problem. However, the modified survey also asks questions regarding what steps one personally takes to reduce mosquito levels, how much time one spends outdoors in the summer, and whether that time is primarily work-related or recreational.

Website

Our website represents a non-interactive source of information, publicly available at https://segue.middlebury.edu/sites/LemonFairMosq. The main page includes a brief introduction to the site. Within the introductory section we included a photograph of our group members, our contact information, and our mission statement. The introductory pages of our website also include a brief history of mosquito control in Vermont and of its established districts, which provides added perspective to those whom this project aims to serve. In addition, this section of the website offers hyperlinks to some recent local news articles on mosquito control.

In the "Maps" section of our website, we uploaded maps of the BLSG and Lemon Fair control districts as well as the two maps of the Lemon Fair district survey results. Both the original and revised surveys are available on the website. Furthermore, we also included an informational section on mosquito life cycles that may help readers better understand our three fact sheets. Finally, the site includes the present document and a list of additional resources that can help interested visitors learn more about mosquitoes and mosquito control.

GPS Work

We did not include the GPS portion of our project on the website, because the maps we created constitute part of a project still in progress. The data that our group has collected with GPS technology, over the course of the semester, represents only a small fraction of the work required to produce meaningful results. The product of our GPS surveying endeavors manifests itself in the form of a recommendation that this work continue, perhaps through a prolonged collaborative effort between Middlebury College Environmental Studies students and the Lemon Fair Insect Control District. We made this recommendation in our public presentation to our community partners and the Environmental Studies community on May 11, 2006. In order to

illustrate the progress we made in identifying mosquito breeding ground, we created a map using the GPS data that we had collected thus far (also see enlarged map in Appendix 2.1).

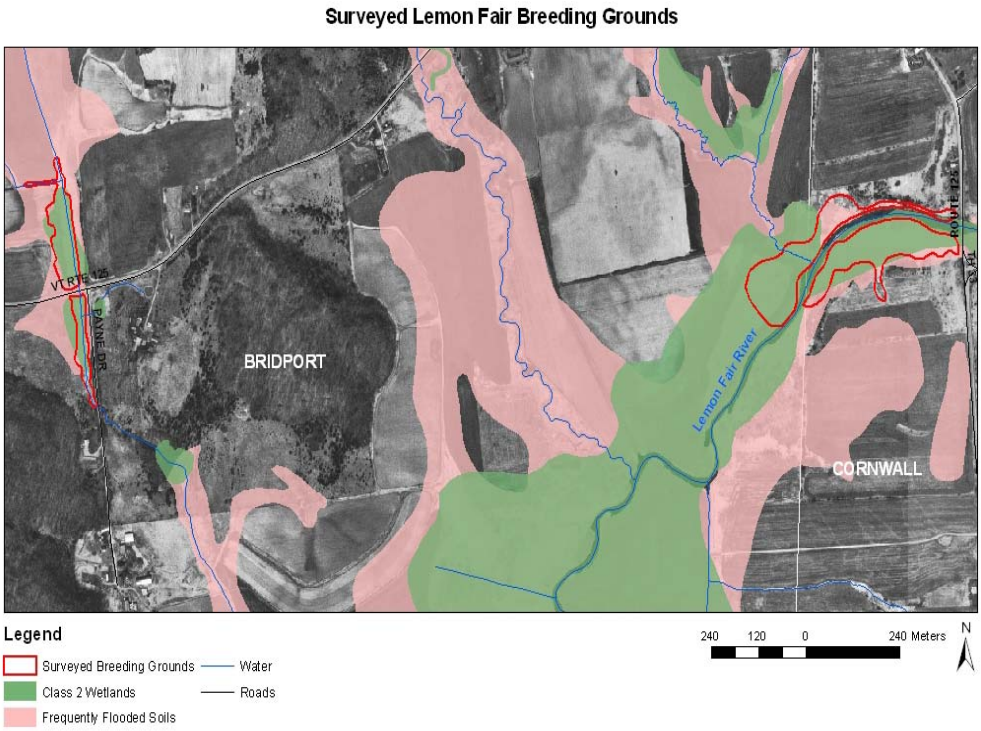


Figure 4: This map shows how the mosquito breeding areas we surveyed, outlined in red, follow the lines of the Lemon Fair River, class 2 wetlands (in green) and the frequently flooded soils (in pink).

The map shows only a small area of Bridport and Cornwall, and what we surveyed covers only a minor portion of the map. Nevertheless, our efforts demonstrated how to survey and map mosquito breeding grounds. We gave Mr. Vanacore a CD containing the GIS files of the area that we surveyed, and we hope that this will serve as a foundation for future GPS projects in Bridport and Cornwall.

Conclusions

We sincerely hope that our project will prove useful to the Lemon Fair Insect Control District, the Salisbury Conservation Commission, the BLSG district, and Vermont residents. There are many areas in which our work can continue into the future. GPS surveying, a potentially major on-going venture, will provide data files and maps that will aid mosquito monitoring in the future.

Moreover, we have identified other kinds of physical data that may prove useful in mosquito management programs. For example, recording levels of rainfall within watersheds and water elevation at multiple points along larger rivers could produce data which, when entered into a GIS model, could greatly expedite the process of locating of mosquito hatches, which occur in well-saturated areas. Pinpointing the location of mosquito hatches soon after they occur is crucial to the control process, because some of the most effective controls can only be implemented during the larval stage, which in many species last only a few days. Additionally, by continuing to periodically survey Vermonters to determine local perceptions of the mosquito problem, control districts can determine the efficacy of their mosquito control programs.

Finally, the endeavor to educate the public about the realities of mosquito control ought to persist. The website provides a location in which to consolidate all the information we have gathered over the course of this project. Though we failed to find a viable way to host an interactive forum, the possibility remains that a database containing information about mosquito control will be hosted by a state agency. We hope one day such a system will help keep updated information about mosquito breeding areas and mosquito control techniques available to a wide audience. The project of mosquito control is in many ways a stimulating arena for new projects

and strategies for gathering and sharing information. We, the Skeeter Beaters, hope that our project will constitute a key piece of the larger puzzle that is mosquito control.

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Turmel, Jon P. State Entomologist. Vermont Agency of Agriculture Laboratory. 103 South Main Street. Waterbury, VT 05671. jon@agr.state.vt.us. (802) 241-3008.

Vanacore, Tom. Lemon Fair Mosquito Control District. Stones32@sover.net. (802) 758-2220.

Material Safety Data Sheets (from Jon Turmel)

Agnique MMF

Anvil 10+10 ULV (pyrethroid)

Permethrin. <http://npic.orst.edu/factsheets/permethrin.pdf>

VectoLex CG

VectoBac CG

Websites

Agency for Toxic Substances and Disease Registry. "DEET Chemical Technical summary for public health and public safety professionals." <http://www.atsdr.cdc.gov/consultations/deet/health-effects.html>

Agnique MMF Mosquito Larvicide and Pupicide. <http://www.mosquitommf.com/mosquito/default.htm>

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Mosquito Control Methods for In and Around Your House and Place of Work

Individual households play an important role in mosquito control! Managing mosquitoes early in the season can cut your expenditures on mosquito repellants and insecticides, reduce your time and labor dedicated to mosquito control, and lessen the impact of repellants and insecticides on the environment.

This fact sheet is broken up into three parts explaining how to control mosquitoes on property at home or at work by tackling the problems of breeding site propagation, larval populations, and adult populations. Within each section is an explanation of the proper procedures for executing each control method.

> BREEDING SITE CONTROLS <

Methods that are taken to attack the problem of larval mosquitoes generally include the management of water bodies on your property through organic and inorganic means.

1) Look for potential or current breeding sites on your property

- Some mosquito species do not travel far distances (e.g., *Culex pipiens, Culex restuans, Culex salinarius, Culex territans)* and may likely have originated nearby or on your own property
- Mosquitoes prefer standing or slow-moving water – after a rain look for areas collecting water
- Some species prefer polluted waters containing organic matter like manure, urine, or leaves (e.g., *Culex pipiens*)
- Look for mosquito larvae or "wrigglers" that can be up to 8 mm long in size (picture below).

- Examples of common household breeding sites: birdbaths, watering cans, containers, clogged roof gutters, dripping faucets, rain barrels, hot tub/pool covers, old tires, recycling bins, stumps and tree hollows, drains, and wheelbarrows
- Tires piled on their sides that are used to anchor bunk silo covers have been found to be a major breeding site for mosquito species in Vermont. See methods for making tires "mosquito resistant" below

2) Eliminate breeding sites

- Remove or drain water-containing objects
- Unclog/repair gutters
- Install screen or fine netting over tops of rain barrels or containers
- Encourage the existence of natural predators (e.g., fish, frogs, toads, dragonflies, hummingbirds, bats); stock backyard ponds with native or game fish approved by Vermont Fish and Wildlife
- "Mosquito-proof" tires or replace with alternatives to full-casing tires
  - drill holes in tires
  - cut tires in half (works for bias-ply tires but not radial-ply)
  - remove tire sidewalls
  - cover unused tires
  - treat tires with mosquito larvicide
  - use alternative to tires, like sidewall disks or tire beads from heavy equipment

> LARVAL CONTROLS <

If physical controls are not sufficient, it may be appropriate to use Biological or Chemical Control Products

Table of Larvicides

Synthetic /Biological	Active Ingredient	Health Risks	Example products
Biological	Bacillus thuringiensis israelensis (Bti)	Virtually non-toxic to humans. Bti may cause mutations in plant cells but there is no sign of these effects in mammals.	Mosquito Dunks™ and Mosquito Bits™
Synthetic	Methoprene	Little risk to humans. In rare cases people may develop skin irritation.	Altosid®, Precor®, Kabat®, Pharorid®,Dianex®, Apex®, Fleatrol®

Mosquito Chemical larvicide precautions

- If you apply mosquito larvicides (pesticides) to your property, make sure they do not leave your property. Do not apply larvicides to any body of moving water such as rivers or streams that may allow larvicides to drift off your property.
- Only use products labeled for mosquito home and garden control.

> ADULT MOSQUITO CONTROLS <

There are two basic ways by which to attack the problem of adult mosquitoes. The first way is to use repellants that do not kill mosquitoes but simply deter them from biting. The second way is to use adulticides that kill mosquitoes.

Tips for the General use of Repellants:

Note: Check to make sure you are using application methods listed on the label for the repellent product.

- Apply any repellents on top of clothing and to any exposed skin. Avoid applying underneath clothing.
- Do not apply any repellents directly on open wounds, cuts, or any other kinds of skin irritations.
- Keep all repellent out of the reach of children. If you need to apply the product to children, apply the repellent to your own hands first and then apply it to the child. Do not apply repellent close to the child's eyes or mouth, and refrain from putting the repellent and the child's hands so that they cannot then rub their eyes or put their fingers in their mouth.
- Repellents do not require heavy applications. Use enough product to cover exposed skin and clothing. If the first application ends up being insufficient, then apply another small amount.
- When going back inside, wash your hands and any other area of skin potentially exposed to the repellent. Taking a shower after applying insect repellent is a good idea (especially if any repellant gets in your hair). Wash all clothing you have applied repellant to before wearing it again.

- If you think you or your child is experiencing a reaction due to the application of a repellant, discontinue the use of that brand, wash the skin that was affected. If you are worried about the severity of the reaction, call your local poison control center. If you go to the doctor, take the repellant with you so that the doctor can know what exactly you think has caused the reaction. This will aid the doctor in helping you or your child.

Limit the need to apply repellants

- If you know that mosquitoes are active, limit your time outside in the mosquito areas. Avoid going outside at dusk
- In your house or work place, keep all windows and doors shut or install screens.
- If you go outside, wear long-sleeved shirts and pants.
- You can use mosquito netting to cover your face and neck and to cover infant strollers.

Table of Repellants

Synthetic / (Organic) Plant Based	Active Ingredient	Protection Time (hours)	Health Risks	Example Products
Organic	Citronella	0-5 *	Skin irritation, allergic reactions (USDA); a component of citronella, methyl eugenol, may cause liver and stomach tumors (U.S. Department of Health and Human Services' national Toxicology program)	Buzz Away Spray, Natrapel®
Organic	Geraniol (found in citronella, lemongrass or rose plant oils)	2-4 *	Moderate eye and skin irritation (EPA); long-term exposure may induce ski irritation (National Institute of occupational Safety and Health)	BugBand™
Organic	p-Methane-3, 8-diol (found in eucalyptus plants; synthesized chemically for commercial use)	2-7	Eye irritation from short-term exposure (EPA); long-term exposure caused microscopic kidney lesions and skin irritation (EPA)	OFF! Botanicals Insect Repellant, Repel Lemon Eucalyptus Insect Repellant
Organic	Garlic-based products	N.A.	Allicin (active ingredient) in garlic may cause skin irritations or allergic reactions	Mosquito Barrier® (this is a repellant, larvicide, and insecticide)
Organic	Soybean Oil	1.5-8 *	Adverse health effects only in subjects where diets were more than 15% soybean oil	Bite Blocker, BIO Block Sport Sun and insect repellant
Synthetic	Deet (diethyltoluamide)	0-5	Side effects are uncommon, however rashes, skin mucous membrane irritation, transient numb or burning lips, dizziness, disorientation, difficulty concentrating, headache, and nausea can occur	OFF! Deep Woods, Sawyer Controlled Release, OFF skintastic, OFF Skintastic for Kids, Gone original Wristband, Repello Wristband

*Depending on the species for mosquito

Facts about Deet

(We chose to include information on Deet because it is so widely used)

- Products containing Deet (diethyltoluamide) are generally used to repel mosquitoes in the out of doors.

- Deet products can prevent mosquito bites for a time period ranging from a couple of hours up to a full day.
- Products with 40% Deet will repel mosquitoes sufficiently on adults. Using products containing a higher percentage of Deet than 40% do not increase your protection time any more than a product containing 40% Deet. Try to refrain from buying products with these higher percentages.
- Deet was designed to be applied directly to the skin for the purpose of repelling many insects, not just mosquitoes.
- The EPA has found Deet products to be safe if they are used in the manner described on the product label.
- For the correct application of Deet, also look to the "Check List of Safety Measures" found at the beginning of this Fact Sheet.
- Children under the age of two months old should not use any product containing Deet.
- Deet is classified by the Environmental Protection Agency (EPA) as a chemical that is "**Not classifiable as to human carcinogenicity.**" This designation is generally used for agents with inadequate human and animal evidence of carcinogenicity or for which no data are available." This means that data are inconclusive about whether or not Deet is carcinogenic.
- For more information on the effects of Deet and other possible carcinogenic pesticides visit the National Pesticide Information Center at this link: http://npic.orst.edu/chemicals_evaluated_July2004.pdf
- For a larger list of Deet and non-Deet products see the *Mosquitozone* web page at this link: http://www.mosquitozone.com/prodprofiles

Adult population Control

Table of Adulticides

Synthetic /(Organic) Plant-Based	Active Ingredient	Protection Time	Health Risks	Example products
Synthetic	Permethrin	N.A.	Allergic type reaction such as skin irritation, inflammation, sneezing, nasal stuffiness, or asthmatic breathing. Possible human carcinogen	Buzz OFF™ clothing, Sawyer Insect Repellant
Synthetic	Malathion	N.A.	At high doses Malathion can overstimulate the nervous system and cause nausea, dizziness, and confusion. Extreme doses can cause convulsions, respiratory paralysis and death. Inconclusive data for malathion carcinogenicity	Ortho Malathion Plus, Bondie Insect Control

Use of Permethrin and Malathion Products:

- Permethrin is a pesticide, not a repellant, and should not be used directly on the skin. Permethrin products should be applied on clothing. You need to keep in mind that permethrin can keep its potency for up to two weeks even if you wash your clothing.
- Malathion should not come in contact with skin. It is important to avoid contact of malathion with the mouth and eyes.

How Does Vermont Control Mosquito Populations?

A guide for citizens of Vermont's insect control districts on the large-scale biological and chemical methods being used for mosquito population control on public and private land*

LARVAL CONTROLS

Many VT mosquito species over-winter in the egg stage. Once eggs begin to hatch in the spring, controlling the larval population before it matures to adulthood is the most effective method of control. This is because during this stage larvicides can be applied specifically to breeding grounds in still waters. The controls available at the larval stage are more mosquito-specific than available adult controls. This is important because it means that mosquitoes can be killed with less damage to beneficial organisms that play a role in a balanced ecosystem and that as predators help keep mosquito populations in check. The following larvicides are used by both of the existing insect control districts in Vermont.

Bacillus thuringiensis israelensis (Bti)

What it is: This is a naturally occurring soil bacterium that targets larvae in the order *Diptera* (mosquitoes and flies). It targets larvae in the feeding stages (first through fourth instar) but does not affect pupae or adults. Bti is the primary tool used by the Agency of Agriculture for mosquito control in the existing control districts.

How it Works: Bti spores are ingested and release toxins into the gut of the targeted mosquito larvae. This causes the insect to stop eating within hours and to die within a few days. The bacterium is only effective in basic environments (pH 9.0-12), such as the digestive tracts of mosquitoes, which allows it to be target specific. The only organisms to which Bti is toxic are mosquitoes and flies.

Application: Bti products are available in the following forms: water dispersible granules, liquid, pellets, and briquettes. Bti is applied by either hand sprayers or in briquette form to water bodies that are breeding grounds for mosquitoes. Hard-to-reach areas are treated by aerial spraying from airplanes or helicopters. Since Bti has a relatively short persistence in the environment, the sprays must be applied relatively frequently (in 2-3 day cycles) for effective control. However, the slow-release briquettes can control mosquitoes for over 30 days.

Advantages: This strain of bacteria is highly target specific. It does not have toxic effects on humans or any other species outside of the Diptera order. No problems of pesticide resistance to Bti have been reported in the US, although other *Bacillus thuringiensis* varieties used as agricultural pesticides have induced resistance in their target species. Bti is a naturally occurring soil organism and an organic-approved insecticide; organic farmers need not worry about losing their certification.

Safety Precautions: Federal laws prohibit directly applying Bti to water bodies that are used for drinking water. Direct exposure to Bti products can cause skin and eye irritation. Areas where there are scheduled larvicide applications should be avoided.

Bacillus sphaericus (Bs)

*Warnings of mosquito control actions are publicized in town newspapers by the Agency of Agriculture 15 days in advance of the start of the season, along with information for private landowners who would like to request that their property be omitted from any specific treatment.

What it is: This is a naturally occurring soil bacterium similar to *Bacillus thurningiensis israelensis* (Bti). Bs targets some specific kinds of mosquitoes, including many that are prevalent in Vermont. It targets larvae in the feeding stages (first through fourth instar) but does not affect pupae or adults. Bs is a secondary control used for mosquito control in Vermont by the Agency of Agriculture.

How it Works: Bs spores are ingested and release toxins into the gut of the targeted mosquito larvae. This causes the insect to stop eating within hours and to die within a few days. Bs works only in fresh water.

Application: Bs comes in water-dispersible granule form. Bs is applied by Vermont workers with either hand sprayers or aerial sprayers mounted to airplanes and helicopters. It is applied to water bodies where mosquitoes breed. Bs persists in the environment from one to four weeks.

Advantages: Bs is effective in deeper water than Bti; it is also effective in water that contains more organic matter, such as wastewater treatment pools. Bs is highly target specific; it has no toxic effects on non-target species (including humans). No problems of pesticide resistance to Bs have been reported in the US. Bs is an organic-approved insecticide; organic farmers need not worry about losing their certification.

Safety Precautions: Federal laws prohibit directly applying Bs to water bodies that are used for drinking water. Bs is not available for commercial use and must be applied by a licensed pesticide applicator. Direct exposure to Bs products can cause skin and eye irritation. Avoid areas where there are scheduled Bs applications.

Agnique

What it is: Agnique is a larvicidal spray that acts as a physical barrier to mosquito development. It consists entirely of its active ingredient, Poly(oxy-1,2-ethanediyl),α-Isooctadecyl-ω-hydroxyl. This liquid is sprayed on waters where mosquito larvae are developing.

How it Works: Agnique does not sink into the water column, but forms a monomolecular (one-molecule-thick) film across the surface of the water. This physically prevents the developing larvae from reaching to the surface for air during the later stages of development when they are transitioning into adult mosquitoes.

Application: The product is sprayed onto standing waters with documented larval presence at the following rates: 0.2-1.0 gallons/acre in fresh or brackish water, or 0.35-1.0 gallons/acre in polluted waters. A fan spray is recommended. Ground or aerial application can be used. The monomolecular layer will spread to cover a larger surface and hard-to-reach areas. The larvicidal film persists 5-22 days. The product may be used in potable or irrigation waters.

Advantages: Aqnique is an effective control agent for any species of mosquito that breeds in standing water and requires the air/water interface in its lifecycle. The product is a useful alternative to biological control agents because it can be applied at a later stage in larval development. Sometimes the larvae are not detected until after the period has passed during which the *Bs* and *Bti* are viable control options, in which case Agnique is the next-best solution. It is a more specific pesticide to mosquitoes than the available adulticides, though not as specific as the bacterial larvicide controls. It can affect some other species, such as midges and a few other arthropods, but has no acute toxic effect on many aquatic animals and plants. There is little or no chance that resistance to this control could develop as it creates a physical barrier to a basic life function.

Safety Precautions: Agnique is not a skin irritant for humans. Studies show that eye irritation in rabbits is mild and reversible within 7 days. In case of contact with skin or eyes, flush with water or wash skin with water and soap. If irritation does develop, medical attention should be sought. Keep out of reach of children.

ADULT CONTROLS

Adult mosquito controls are a useful backup option in mosquito control. If a hatch of mosquitoes is missed during the larval period, it can mature into an adult mosquito population. Additionally, an adult mosquito population may include mosquitoes with a further range that hatch outside of the control district. To deal with a dense adult mosquito population, there are several products and solutions available for personal and household use. For more information on these, see the Household Mosquito Control Fact Sheet, available on our website. Though preliminary investigations are being done on alternative adult repellents, such as garlic and cinnamon sprays, the major adulticidal agents in use in Vermont are pyrethroid chemical sprays. At this time pyrethroid adult controls have been and are being used as a backup to larval controls in the Brandon-Leicester-Salisbury-Goshen control district only.

Pyrethroids

What they are: Pyrethroids are a type of chemical that comprise the major form of adulticide being used for mosquito control in Vermont. They are synthetic chemicals modeled after the naturally derived pyrethrin, which is a product of chrysanthemums, and include permithrin, cypermethirn, fenvalerate, bifenthrin, esfenvalerate, and flucythrinate. They are a general biocide, not specific to mosquitoes. The active ingredients of Anvil® 10+ 10 ULV (the Clarke pyrethroid product used in the state of Vermont) are 3-Phenoxybenzyl-(1RS, 3RS; 1RS, 3SR)-2,2-dimethyl-3-(2-methylprop-1-enyl) cyclopropanecaboxylate (10%) and Piperonly Butoxide, Technical (10%).

How they work: The pyrethroid compounds work similarly to organochlorine insecticides such as DDT, which is banned in the US, and several others that are currently used. Pyrethroids work by poisoning insects upon contact, via the nervous system. Some may also disrupt the endocrine system. They have very high acute toxicity to insects and aquatic organisms, including fish. They also have moderate acute toxicity to mammals and birds.

Application: The liquid biocide is sprayed at ground level either with backpack sprayer or by trucks. Droplets must be 5-25 microns in diameter. It is applied at night in areas with a high density of adult mosquitoes in order to target the mosquitoes and limit the risk of human exposure. It is applied at a rate of 0.0012-0.0036 lbs. /acre. Generally, pyrethroids are truck-sprayed along roads. Aerial application is also a possibility. It is important not to apply the product to bodies of water or areas where surface water is present, as the product will contaminate water and is toxic to fish and other aquatic organisms.

Advantages: Pyrethroids, unlike other controls, can be used for mosquito control once insects have developed to mature bodies. They are highly effective at killing adult mosquitoes that come into contact with the spray. Very little spray is needed so that it disperses quickly and leaves no observable residues on surfaces.

Safety Precautions: Anvil® 10+ 10 ULV is harmful if absorbed through the skin. Humans should thus avoid contact with skin, eyes, or clothing. In case of contact, flush with water, but do not induce vomiting as there is a risk of aspiration pneumonia. Also, avoid pyrethroid contact with food or water supplies. Cleaning of contaminated equipment and waste disposal should avoid contamination of bodies of water or wetlands. Keep out of reach of children.

Mosquito-Transmitted Diseases in VT

A Vermont guide to the risks of mosquito transmitted disease.
While cases of these diseases are rare, especially in Vermont, it is important to know the facts so that informed decisions can be made.

West Nile Virus (WNV)

The West Nile Virus initially appeared in the United States in 1999 in New York, where 62 people became ill and seven died. Humans beings become infected with West Nile through the bite of a mosquito that has already contracted the virus. Birds serve as the primary reservoir of West Nile and mosquitoes become infected after feeding the blood of those that have the virus. In turn, when a mosquito bites a human, it injects the virus into that person. In Vermont, traces of the virus have been detected in dead birds, mosquitoes, and horses. The first and only documented case of a human WNV infection in Vermont occurred in 2002.

WNV: What is the risk of infection?

The risk of infection is highest for people living or working in areas with high rates of infected mosquitoes. Currently, Vermont mosquitoes are relatively safe as there have been only one human case of WNV in the state.

WNV: If infected, what happens?

Of those people infected with the virus, few actually ever show any signs or symptoms. About 20% of infected people become mildly ill, and less than 1% become severely ill. Individuals of 50 years or more and people with impaired immune systems run the highest risk of becoming seriously ill after becoming infected with WNV. Common signs and symptoms of mild illness from West Nile may persist for only a few days or for as long as several weeks and include:

Fever	Lack of appetite
Headache	Nausea, vomiting, and diarrhea
Muscle aches	Skin rash
Backache	Swollen lymph nodes

In less the less than 1% of people who have more serious complications from West Nile, the virus can cause a more acute neurological disease such as inflammation of the brain (encephalitis), inflammation of the membranes and fluid surrounding the brain and spinal cord (meningitis), or both. Signs and symptoms of these diseases include:

High fever	Disorientation or confusion
Severe headache	Tremors or muscle jerking
Stiff neck	Signs and symptoms of Parkinson's disease
Stupor or coma	Incoordination
Convulsions	Partial paralysis

WNV: If infected what can be done?

There currently exist no specific remedies or regimens with which to treat it, though cold-like symptoms can be alleviated. Severe cases, however, may necessitate hospitalization or treatment in an intensive care unit.

WNV: How can I prevent infection?

There are currently no vaccines available against West Nile Virus. The most effective means of preventing West Nile virus infection involves limiting one's exposure to mosquitoes. Refer to the following page concerning EEE for advice on how to limit contact with mosquitoes. There currently exists no evidence that one can catch the West Nile virus from handling dead birds. Nevertheless, one should always wear gloves when handling dead birds or any other animal. West Nile cannot be transmitted directly between human beings.

Eastern Equine Encephalitis (EEE)

Eastern Equine Encephalitis is a mosquito-borne, neurological disease that affects birds, horses, and humans. While the primary vector of the disease is the species *Culiseta melanara*, one that only feeds on birds and has not been found in VT, EEE has also been found in species of *Ades* and *Culex* which are present in Vermont. These species feed on humans and equines.

EEE: What is the risk of infection?

The United States has had 220 reported cases since 1964, with an average of 5 cases per year. The disease occurs almost exclusively within the eastern half of the country. However, there has never been a case of EEE in Vermont. The northernmost state with a recorded infection is New Hampshire (1 in 1980). Most reported cases come from New Jersey, Florida Georgia, and Massachusetts. The people at the highest risk are those who work or spend time in areas where the disease is endemic and are exposed to mosquitoes. Areas where the disease is endemic primarily consist of fresh water swamps surrounding hardwood forests. Human infection has been limited because of the lack of human presence in these areas. However, shifting climates and warmer temperatures due to global warming could affect the overall range of mosquitoes carrying this disease.

EEE: If infected, what happens?

For most people infected with the disease the symptoms will be similar to a mild flu. Headaches, fever, nausea, muscle ache, and disorientation are the most common side effects and will show up approximately 3-10 days after infection. There is an increased risk for infected people over the age 50 and under 15, as well as others who may have depleted or unhealthy immune systems. While most cases are mild, those at increased risks could be subject to seizures, coma, and death. Approximately 1/3 of those infected die, making EEE the deadliest mosquito-borne virus in the U.S.

EEE: If infected what can be done?

Currently there is no specific treatment outlined to address EEE other than taking optimal care in reducing the symptoms it brings on. In severe cases hospitalization or supportive care is necessary. People who suffer from severe cases may have permanent brain damage and need subsequent after-care. After a primary infection people become immune to contracting the disease again.

EEE: How can I prevent infection?

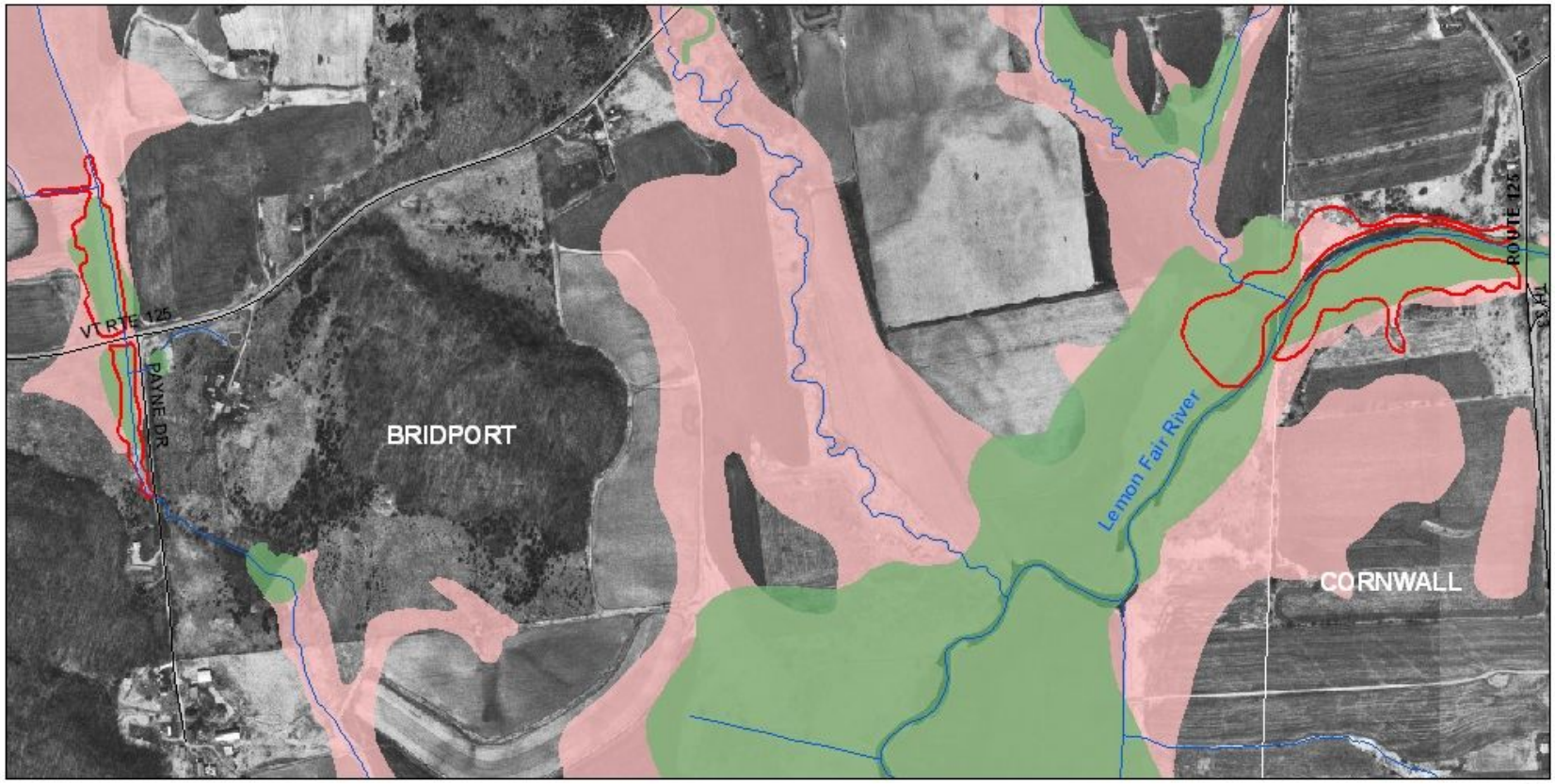
To prevent EEE infection stay away from known mosquito areas where the disease has been reported. Avoid outdoor activity during dawn or dusk; wear a long sleeve shirt if you are outside at these times. Insect repellent is also an option for greater protection. Please refer to "Mosquito Control Methods for in and around your House" for the proper use of repellents.

Other Mosquito-Transmitted Diseases

As listed by the Department of Health and Human Services Center for Disease Control and Infection, mosquito-transmitted diseases worldwide include the arboviral enciphalitides (such as EEE and WNV), malaria, dengue, yellow fever, and rift valley fever. Of these diseases, only EEE and WNV have been reported in or near Vermont. Most of the others are endemic to tropical areas.

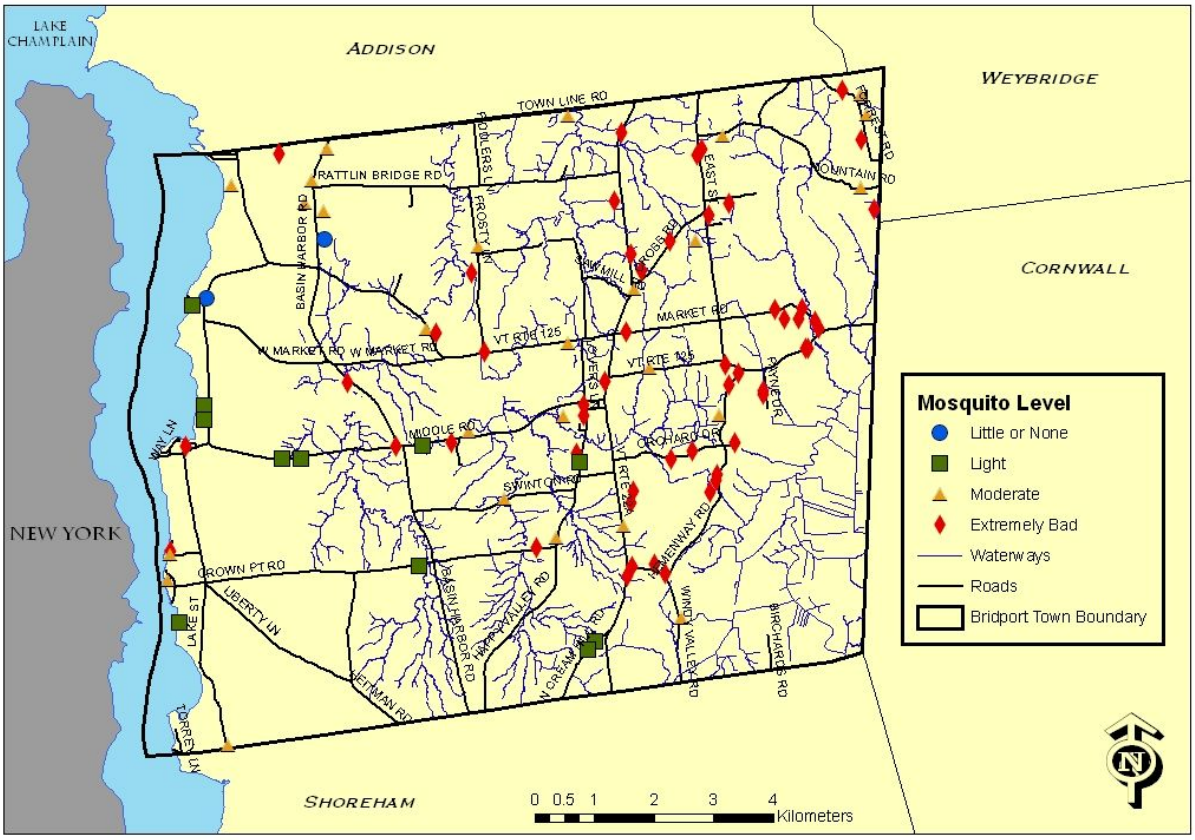
Appendix 2.1

Surveyed Lemon Fair Breeding Grounds



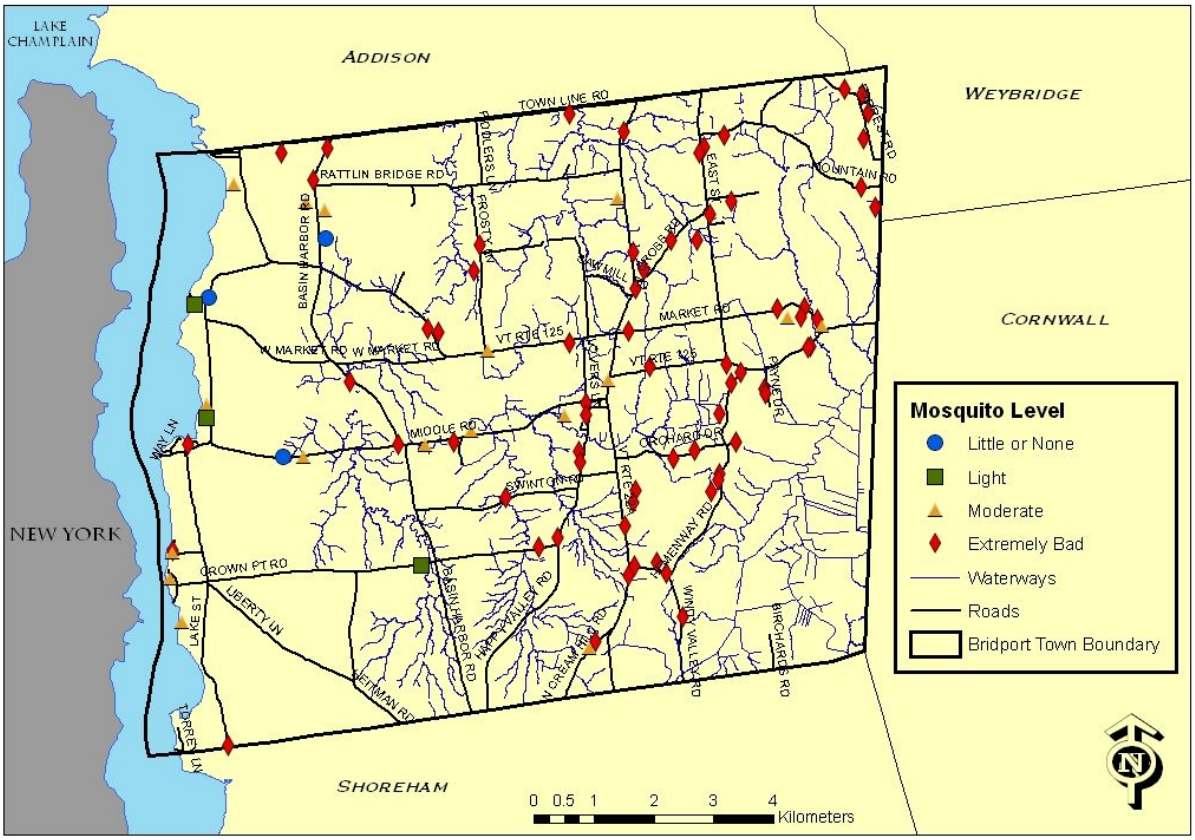
Appendix 2.2

2004 SURVEY RESULTS



Appendix 2.3

2005 SURVEY RESULTS



Original Lemon Fair Mosquito Control District Survey

Please answer these questions regarding mosquito levels in your neighborhood over the last year. Don't forget to give your name and street address including the 911 number. If you wish to remain anonymous, give a general location by identifying your road and proximity to any wetlands near by. Feel free to give more specific information such as the duration of infestation or location of known or suspected breeding grounds in your area. If you wish to volunteer for the effort, check the box at the bottom of the page. Thank you.

Please check one description for each year.

2004 **Extremely High** ____

Moderate ____

Light ____

Little or None ____

2005 **Extremely High** ____

Moderate ____

Light ____

Little or None ____

Any additional information or comments?

Address: Name _____

Street _____

Interested in volunteering? **YES** ____

Please return this survey ASAP to the town clerk or to the collection box at town meeting. Thank you for your help.

Lemon Fair Mosquito Control District

Bridport voted to establish the Lemon Fair Mosquito Control District. This district now includes all the territory within the towns of Bridport and Cornwall, and may include Weybridge should their voters decide to join on town meeting day. Each member town appoints three commissioners to a board which will oversee the operations of the control program. These members will report to their respective select boards. The financing will be maintained by equal contributions from the member towns, now standing at $40,000. per town. The State of Vermont will reimburse the district for as much as 100% of the direct costs associated with the treatment program as long as this program targets the larvae in breeding waters. The State also provides technical assistance and laboratory work to identify species.

The primary method of control is to treat mosquito infested breeding waters with a bacteria specific to the mosquito larva before it turns into the flying insect. In most areas, including the known breeding grounds in the Lemon Fair Valley, the larvicide will be applied by air using a fixed wing plane or helicopter. This larvicide is the safest known material for its purpose and is accepted by both the USDA and the Vermont Organic Farming Association certification programs. The control district will not be spraying for the adult mosquito for two reasons: The State will not financially support this aspect of a program and experience has shown that spraying the necessary chemicals from the ground is expensive in material and infrastructure and has little lasting effect. Instead, the district will help educate landowners about options for controlling both breeding habitat and the flying insect on their own property.

The district is encouraging townspeople to participate in the ground surveying and monitoring process. The commission will set up and maintain a data base incorporating the mapping of major breeding grounds, weather conditions, water levels and other related information. During the control season volunteers are needed to monitor breeding waters. Training will be provided. Anyone who wishes to be involved in any aspect of the control effort should contact the commission through the town clerk.

Please take a minute to fill out the survey on the reverse of this page. →

The information will be used to help locate the breeding areas in your neighborhood.

Revised Lemon Fair Mosquito Control District Survey

Please answer these questions regarding mosquito levels in your neighborhood over the last year. Don't forget to give your name and street address including the 911 number. If you wish to remain anonymous, give a general location by identifying your road and proximity to any wetlands near by. Feel free to give more specific information such as the duration of infestation or location of known or suspected breeding grounds in your area. If you wish to volunteer for the mosquito control/monitoring effort, check the box at the bottom of the page. Thank you.

How would you describe the mosquito annoyance and/or density level on your property for the year **2006**?

Extremely High ____
High ____
Moderate ____
Low ____
Little or None ____

How did mosquito levels this year differ from last year?
Increased____ **Decreased**____ **Stayed the same**____

Have you taken measures to reduce mosquito levels: **At work**____ **On your property**____
If yes, how? If no, why not?

During the summer, how much time, on average, do you spend outside per day? ____**hours**
The time you spend outside is: **Work related**____ **Recreational**____ **Other**____

Any additional information or comments?

Address: Name _____

Street _____

Are you interested in volunteering for the mosquito control/monitoring effort? **Yes** ____

Did you participate in this survey last year? **Yes** ____

Please return this survey ASAP to the town clerk or to the collection box at town meeting. Thank you for your help.

Lemon Fair Mosquito Control District

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